Earth's Atmosphere

ES-4 The student will demonstrate an understanding of the dynamics of Earth's atmosphere.

ES-4.2 Summarize the changes in Earth's atmosphere over geologic time (including the importance of photosynthesizing organisms to the atmosphere).
Taxonomy level: 2.4-B Understand Conceptual Knowledge

Previous/future knowledge: Students have not been introduced to the concept in this indicator in any previous grade.

It is essential for students to know that Earth's early atmosphere was probably composed mainly of methane and ammonia. In the early forming of Earth, its surface was much more volcanically active than it is today.

- Earth's primitive atmosphere changed as erupting volcanoes emitted gasses such as water vapor, chlorine, carbon dioxide, hydrogen, and nitrogen.
- As the planet cooled, the water vapor condensed and absorbed most of the carbon dioxide; rains began to fall.
- Oxygen was probably formed from the breaking down of water molecules and also by photosynthesis of primitive cyanobacteria. Large mats and mounds of billions of cyanobacteria dominated the shallow oceans of Precambrian Earth. These organisms generated large amounts of oxygen, some of which also formed ozone, which, in turn, filtered out UV radiation so that other forms of life could survive on Earth's surface.
- As it appears, nearly all the oxygen that living things breathe today, and the oxygen that all animals have breathed in the geologic past, was released into the atmosphere primarily by photosynthesis.

It is not essential for students to know the details of photosynthesis or the processes by which volcanoes produce and spew gases during eruptions. An understanding of the evidence geologists have found in regards to early Earth's atmosphere is interesting but not essential.

Assessment Guidelines:
The objective of this indicator is to *summarize* the changes that have occurred to Earth's atmosphere over time; therefore, the primary focus of assessment should be to generalize major points about these changes and their causes, including the role of photosynthesizing organisms.
In addition to *summarize* appropriate assessments may require students to:

- *compare* the atmosphere of Earth today with Earth's earlier atmospheres; or
- *identify* causes of change to Earth's atmosphere.